Morphology and Internal Geometry and Stratification of Highstand and Transgressive Deposits: Comparison and Contrast, Gulf of Lions and Central Adriatic Sea

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LONG-TERM GOALS

The long-term goal of our research is to improve our understanding of how marine sedimentary strata accumulate and how they combine to form characteristic stratigraphic sequences, such as drapes, aprons, wedges, sigmoids, and other well-recognized geometrical patterns. Recognizing diagnostic sediment geometries, as represented by acoustic reflectors in the upper 50 m of the shoreface, continental shelf and continental slope is critical to interpreting the evolution of sedimentary strata and sequences and inferring the mechanisms of sediment transport and deposition. Interpreting the signatures of various processes in near-surface deposits provides a critical link between knowledge gained from measuring physical processes that are dominant over time spans from the duration of a single event to several years, and those inferred from interpretations of entire stratigraphic sequences on continental margins that may represent much longer (centuries to millennia) periods of deposition.

OBJECTIVES

We were funded by ONR to participate in the US-European planning and research studies for the stratigraphy component of EuroSTRATAFORM. This included active participation and leadership in collaborative workshops and conduct of studies of shallow stratigraphy in the Gulf of Lions. The objective of our field research was to identify the character and origin of sediment bodies on the continental shelf surrounding and within the Cap de Creus Canyon. Overall, our study emphasizes the internal architecture and evolutionary growth of geologically young shelf and nearshore sediment bodies.

EuroSTRATAFORM is a North American–European research program to observe, measure and model the processes—from long-term climatic cycles to short-term storm events-- that erode, transport, and deposit sediment on continental margins. The study emphasizes the processes and events that create and destroy sedimentary strata over time scales ranging from weeks to millennia. Key to this objective

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is collaboration and integration of results with European colleagues. A crucial part of this study was active participation in the planning of stratigraphic studies with colleagues in Italy (IMG, Bologna) and France (IFREMER, Brest)

APPROACH

Our approach was two-fold. First, we provided collaborative assisitance to European colleagues for planning and coordinating large drilling operations, stratigraphic modeling, and interpretation of pre-existing data sets from the continental shelves of the Adriatic Sea and Gulf of Lions.

Secondly, we organized and led a high-resolution CHIRP survey of the area surrounding the Cap de Creus Canyon in 2004 to provide information on sediment patterns and history that would feed into both on-going process studies in and around the Canyon, and interpretation of pre-existing data sets from the central and northern Gulf of Lions.

WORK COMPLETED

More than 200 km of high-resolution seismic reflection data were collected in October 2004 from the Cap de Creus canyon area, in water depths ranging 30 m - 600 m., to characterize the geologic framework and sedimentary environments of the continental shelf, slope and canyon. This area of the southwest portion of the Gulf of Lions is the focus of active research as part of the EuroSTRATAFORM project funded by the Office of Naval Research.

The data were acquired using the U.S. Geological Survey‘s (USGS) high-resolution Edgetech CHIRP 512i seismic reflection system aboard the R/V Oceanus at a depth of approximately 15 meters and at a ship speed of approximately 4 knots. A 30 ms swept-frequency (500 to 7200 Hz) "chirp" source signal was emitted 1 to 4 times per second depending on water depth and the returning reflections were detected by hydrophones located along the bottom of the fish. All data were recorded with a Delph Seismic PC-based digital recording system and processed with Delph Seismic software. Differential GPS position fixes were written into the seismic data trace headers and are also available in an ASCII text file. Processed sections were georeferenced into tiff images for digital archive, processing and display. Penetration ranged 20-80 m. The data feature high quality vertical cross-section imagery of numerous sequences of Quaternary seismic stratigraphy.

For publication and distribution, the seismic profiles were converted from Delph Seismic proprietary format to standard SEG-Y format and to CGM plot files using Paradigm Focus software. Then the CGM files were converted to 300 dots per inch JPEG image file using Larson CGM to Image software. The SEG-Y data files and the JPEG image files are available for download from the on-line report: Grossman, E. G., Hart, P. E., Field, M. E., and Triezenberg, P., 2006, High-resolution CHIRP seismic reflection data acquired from the Cap de Creus shelf and canyon area, Spain, in 2004. U.S. Geological Survey Open File Report 2006-1247, available at http://pubs.usgs.gov/of/2006/1247/
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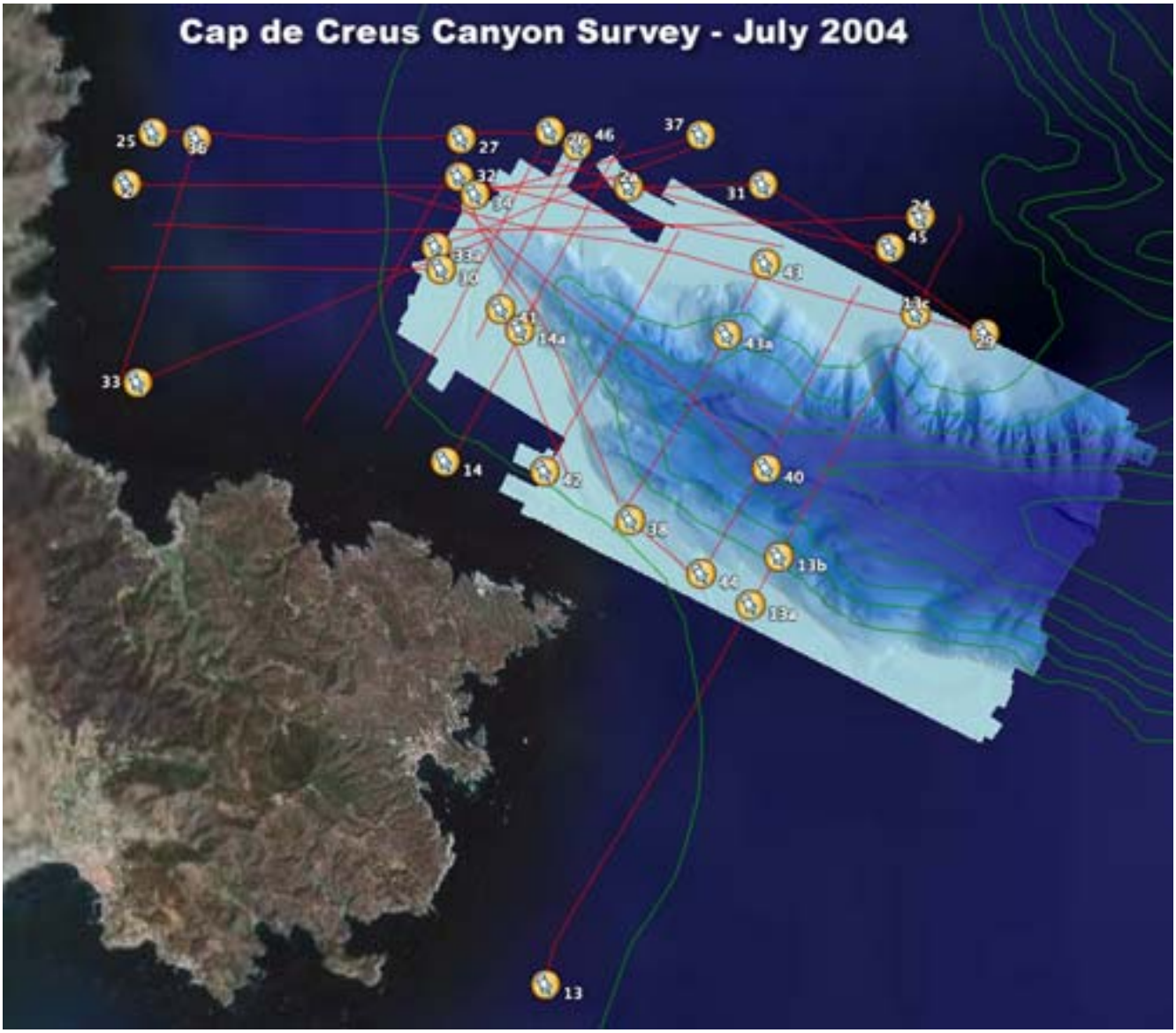
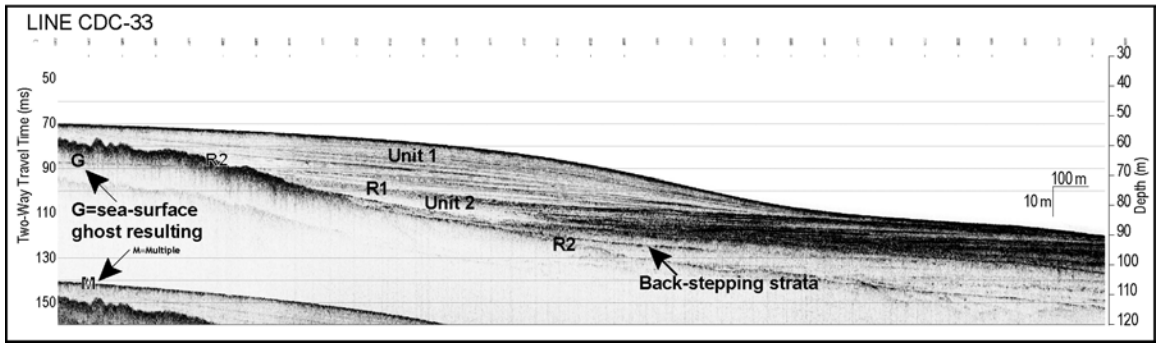


Map of the high-resolution CHIRP survey area of Cap de Creus Canyon and adjacent shelf. The CHIRP profiles can be viewed and downloaded from Grossman et al. 2006 at: http://pubs.usgs.gov/of/2006/1247/



Interpreted CHIRP seismic reflection profile. Surface R1 separates two unique sediment units (units 1 and 2). Unit 2 is characteristic of a back-stepping transgressive sequence comprised of moderate amplitude, parallel, flat-lying reflectors that onlap surface R2. In contrast, Unit 1 shows sigmoidal to parallel reflectors of lower amplitude that onlap R2 and downlap R1 likely reflecting a change in sedimentation, perhaps an increase in sediment input.

RESULTS

Key sedimentary features imaged in this study and examined as part of the Cap de Creus project include lowstand, transgressive and highstand deposits, each having a characteristic acoustic signature. Collectively, the deposits are important indicators of latest sea-level history; in some locales the highstand deposits are recorders of impacts from human intervention in drainage basins. They are also areas of potential hazards, as the rapid accumulation patterns that characterize many highstand deltas elsewhere can lead to instability.

The reports by Grossman et al. (2005, 2006) provide new information on the location and thickness of sediment deposits overlying a major erosion surface on the Cap de Creus shelf; they also provide new insight into sediment processes on the walls and in the channel of Cap de Creus Canyon. These data are under study by researchers at the US Geological Survey, the University of Barcelona, and Texas A and M University. The report and data are publicly available at: http://pubs.usgs.gov/of/2006/1247/

IMPACT/APPLICATIONS

Our study was carried out to provide a critical link for EuroSTRATAFORM colleagues conducting studies of short-term physical processes and those developing models of continental shelf deposition (e.g. Schoolmeester et al., 2005). All data and preliminary interpretations have been publicly distributed.

PUBLICATIONS

Grossman, E. G., Hart, P. E., Field, M. E., and Triezenberg, P., 2006, High-resolution CHIRP seismic reflection data acquired from the Cap de Creus shelf and canyon area, Spain, in 2004. U.S. Geological Survey Open File Report 2006-1247. (http://pubs.usgs.gov/of/2006/1247/)

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